

Table 4. Ecological Management Zones in which programmatic actions are proposed that will assist in the recovery of species and species groups (continued).

Species and Species Group Visions	Ecological Management Zone ¹													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Suisun Song Sparrow		●												
San Pablo Song Sparrow		●												
Species with the Designation "Contribute to Recovery"														
California Clapper Rail		●		—										
California Black Rail	●	●												
Swainson's Hawk	●	●							●	●	●	●	●	
Salt Marsh Harvest Mouse		●												
San Pablo California Vole		●												
Sacramento Perch	●	●	●	●							●	●	●	●
Riparian Brush Rabbit	●												●	
San Joaquin Valley Woodrat	●												●	
Greater Sandhill Crane	●													
California Yellow Warbler	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Least Bell's Vireo	●	●	●	●								●		
Western Yellow-Billed Cuckoo	●		●									●	●	
Bank Swallow			●	●										
Little Willow Flycatcher				●					●		●	●	●	

Table 4. Ecological Management Zones in which programmatic actions are proposed that will assist in the recovery of species and species groups (continued).

Species and Species Group Visions	Ecological Management Zone ¹													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Giant Garter Snake	•	•				•	•		•		•	•	•	
Delta Green Ground Beetle	•	•												
Saltmarsh Common Yellowthroat		•												
Bristly Sedge		•												
Point Reyes Bird's-Beak		•												
Crampton's Tuctoria	•									•				
Delta Mudwort and Delta Tule Pea	•	•												
Alkali Milk-Vetch		•	•			•				•	•	•	•	•
Delta Coyote-Thistle	•		•									•		
Species with the Designation "Maintain"														
Mad-dog Skullcap											•			
Rose-Mallow		•	•									•		
Eel-grass Pondweed	•					•	•	•	•	•	•		•	
Colusa Grass		•	•			•				•	•	•	•	•
Boggs Lake Hedge Hyssop and Green's Legenere		•	•	•	•	•	•	•	•	•	•			
Contra Costa Goldfields		•								•				•

Table 4. Ecological Management Zones in which programmatic actions are proposed that will assist in the recovery of species and species groups (continued).

Species and Species Group Visions	Ecological Management Zone ¹													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Recurved Larkspur and Heartscale	•	•				•	•	•		•		•	•	•
California Freshwater Shrimp		•												
Hardhead	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Western Least Bittern	•	•	•	•								•		
California Red-Legged Frog	•	•				•	•		•		•	•	•	•
Western Pond Turtle	•	•				•	•		•		•	•	•	
California Tiger Salamander	•													
Western Spadefoot	•													
Species with the Designation "Enhance and/or Conserve Biotic Communities"														
Lamprey	•	•	•	•	•		•	•	•	•	•	•	•	
Native Resident Fish Species	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Native Anuran Amphibians	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Waterfowl	•	•	•	•	•	•	•	•	•		•	•	•	•
Shorebird and Wading Bird Guild	•	•											•	
Neotropical Migratory Bird Guild	•	•	•	•						•	•	•	•	•

Table 4. Ecological Management Zones in which programmatic actions are proposed that will assist in the recovery of species and species groups (continued).

Species and Species Group Visions	Ecological Management Zone ¹													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Bay-Delta Foodweb Organisms	•	•												
Plant Communities	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Species with the Designation "Maintain and/or Enhance Harvested Species"														
White Sturgeon	•	•	•	—				•				•		
Striped Bass	•	•	•					•	•			•		
American Shad	•	•	•					•	•			•		
Non-native Warmwater Gamefish	•	•	•							•	•	•	•	•
Pacific Herring		•												
Grass Shrimp		•												
Signal Crayfish	•		•											
Upland Game	•		•	•						•	•	•	•	•

¹ 1 = Sacramento-San Joaquin Delta
 2 = Suisun Marsh/North San Francisco Bay
 3 = Sacramento River
 4 = North Sacramento Valley
 5 = Cottonwood Creek
 6 = Colusa Basin
 7 = Butte Basin

8 = Feather River/Sutter Basin
 9 = American River Basin
 10 = Yolo Basin
 11 = Eastside Delta Tributaries
 12 = San Joaquin River
 13 = East San Joaquin Basin
 14 = West San Joaquin Basin

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◆ ECOLOGICAL MANAGEMENT ZONES

INTRODUCTION

The following section provides the ecological management zone visions for the 14 areas that compose the ERPP study area. These include the following ecological management zones:

- Sacramento-San Joaquin Delta
- Suisun Marsh/North San Francisco Bay
- Sacramento River
- North Sacramento Valley
- Cottonwood Creek
- Colusa Basin
- Butte Basin
- Feather River/Sutter Basin
- American River Basin
- Yolo Basin
- Eastside Delta Tributaries
- San Joaquin River
- East San Joaquin
- West San Joaquin.

DISTINGUISHING CHARACTERISTICS

Understanding the structure, function and organization of ecosystems is necessary for planning and implementing environmental restoration, rehabilitation and protection projects. Such understanding enables managers to assess, during planning phases of a program, the degree to which prospective restoration sites diverge from a "healthy" or "natural" condition, as well as to evaluate, after actions have been undertaken, project progress and effectiveness. In a management context, perhaps the most practical means of summarizing the most relevant existing information on ecosystems is to develop, over an appropriate hierarchy of spatial and ecological scales, a list of key system attributes - those fundamental natural ecological characteristics that together define and distinguish these systems, their status, and/or their interrelationships. Such lists of attributes may serve as a convenient and necessary "check list" of environmental factors that might be addressed in an ecological restoration/rehabilitation context. At sites for which comprehensive restoration is the goal, a full suite of applicable attributes would presumably be addressed. More commonly, at sites where partial restoration (rehabilitation) is the goal,

actions and efforts would be focused upon an appropriate subset of attributes.

Some individual system attributes - such as water temperature - may be evaluated directly. Others, such as "habitat continuity," are more nebulous, and must be evaluated by developing appropriate "indicators" - measurable parameters that provide a means to objectively (preferably quantitatively) evaluate individual attributes that in themselves are not readily measured. The term indicators is also used in a broader context to refer to a *subset* of system attributes (or their measurable parameters) that are derived and used as a *group* to provide a convenient way to evaluate *overall* system status. Thus, the term "indicator" is commonly used in two somewhat different ecosystem management/restoration contexts, representing two differing scales of resolution: that of *individual* attributes, or alternately, that of *groups* of attributes. In either case, "indicators" are simply a convenient way of measuring or evaluating that which is of primary concern - system attributes. An additional, and most useful tool in understanding and describing fundamental characteristics of complex systems is the use of conceptual models that integrate and diagrammatically represent the three basic *kinds* of system components: elements (attributes), their states, and the relationships that affect attribute states.

ECOSYSTEM TYPOLOGY

The ERPP study area is divided into four ecological zones, based on similarities and differences in their respective attributes. (Refer to the Key Ecological Attributes of the San Francisco Bay-Delta Watershed section of ERPP Volume I for additional details regarding the ecosystem typology.) The ecological zone designations follow:

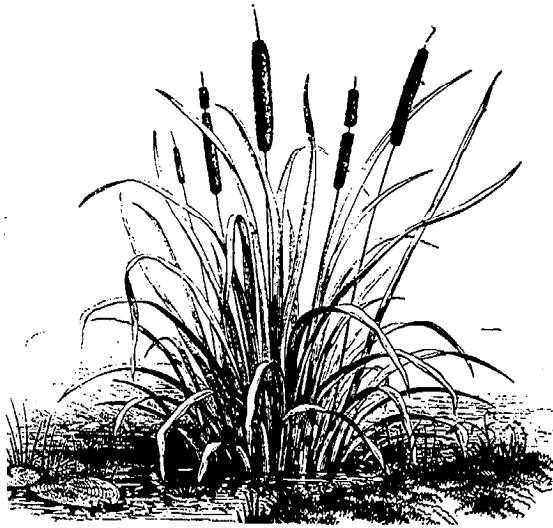
- Upland River-Floodplain Ecological Zone
- Alluvial River-Floodplain Ecological Zone
- Delta Ecological Zone
- Greater San Francisco Bay Ecological Zone

Each of the 14 ecological management zone is contained within one or more ecological zones. The following tables display the distribution of ecological managements zones within each ecological zone.

Table 5. Distribution of Ecological Management Zones within the Ecological Zone Typology.

Ecological Management Zone	Ecological Zone			
	Upland River-Floodplain	Alluvial River-Floodplain	Delta	Greater San Francisco Bay
Sacramento San Joaquin Delta			●	
Suisun Marsh/North San Francisco Bay	○			●
Sacramento River		●		
North Sacramento Valley	●	○		
Cottonwood Creek	●			
Colusa Basin	●	●		
Butte Basin	●	○		
Feather River/Sutter Basin	○	●		
American River Basin	●	●		
Yolo Basin	●	●		
Eastside Delta Tributaries	○	●		
San Joaquin River		●		
East San Joaquin		●		
West San Joaquin	●			
● Denotes primary ecological zone, ○ Denotes secondary or less prevalent ecological zone.				

◆ SACRAMENTO-SAN JOAQUIN DELTA ECOLOGICAL MANAGEMENT ZONE



INTRODUCTION

The Sacramento-San Joaquin River Delta (Delta) is the tidal confluence of the Sacramento and San Joaquin rivers. Between the upper extent of tidewater (i.e., near the city of Sacramento on the Sacramento River and Mossdale on the San Joaquin River) and the confluence of the two rivers near Collinsville is a maze of tidal channels and sloughs known as the Delta. Once a vast maze of interconnected wetlands, ponds, sloughs, channels, marshes, and extensive riparian strips it is now islands of reclaimed farmland protected from flooding by hundreds of miles of levees. Remnants of the tule marshes are found on small "channel" islands or shorelines of remaining sloughs and channels.

The Delta is home to many species of native and non-native fish, waterfowl, shorebirds, and wildlife. All anadromous fish of the Central Valley either migrate through the Delta or spawn in, rear in, or are dependent on the Delta for some critical part of their life cycle. Many of the Pacific Flyway's waterfowl and shorebirds pass through or winter in the Delta. Many migratory song birds and raptors migrate through the Delta or depend on it for nesting or wintering habitat. Despite many changes, the Delta remains a productive nursery grounds and migratory route for many species. Four runs of chinook salmon,

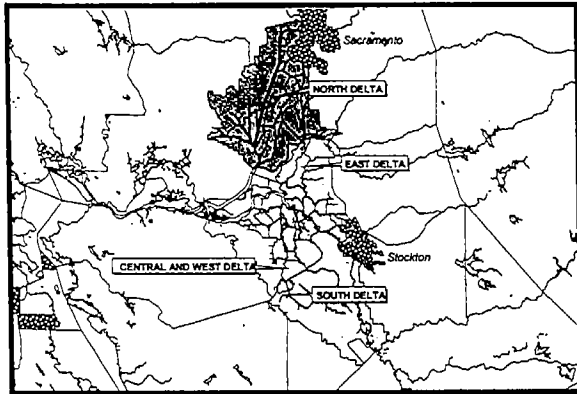
steelhead, green sturgeon, white sturgeon, lamprey, striped bass, and American shad migrate through the Delta on their journey between the Pacific Ocean and Central Valley spawning rivers. Native resident fish including delta smelt and splittail spend most of their lives within the Delta. Considerable areas of waterfowl and wildlife habitat occur along the channels and sloughs and within the leveed agricultural lands.

The Delta also supports many plants with restricted distribution and some important plant communities. Special status plant species include Mason's lilaeopsis, rose-mallow (hibiscus), cel-grass pondweed, Delta tule pea, and Delta mudwort. Important plant groups or communities include pondweed with floating or submerged leaves, bulrush series, cattail series, common reed series, vernal pool communities, black willow series, narrowleaf willow series, white alder series, buttonbush series, Mexican elderberry series, and valley oak series.

Ecological factors having the greatest influence on Delta fish and wildlife include freshwater inflow from rivers, water quality, water temperature, channel configuration and hydraulics, wetlands, riparian vegetation, and diversity of aquatic habitat. Stressors include water diversions, channelization, levee maintenance, flood protection, placement of rock for shoreline protection, poor water quality, legal and illegal harvest, wave and wake erosion, agricultural practices, conversions of agricultural land to vineyards, urban development and habitat loss, pollution, and introductions of non-native plant and animal species.

DESCRIPTION OF THE MANAGEMENT ZONE

The Sacramento-San Joaquin Delta Ecological Management Zone is defined by the legal boundary of the Sacramento-San Joaquin River Delta. It is divided into four regional Ecological Management Units: North Delta, East Delta, South Delta, and Central and West Delta Ecological Management Units.



Location Map of the Sacramento-San Joaquin Delta
Ecological Management Zone and Units.

The Delta is the easternmost portion of the estuary, and today is clearly delineated by a legal boundary that includes the areas that historically were intertidal, along with supratidal portions of the floodplains of the Sacramento and San Joaquin rivers. Today's legal Delta extends between the upper extent of the tidewater (near the city of Sacramento on the Sacramento River and Mossdale on the San Joaquin River) and Chipps Island to the west, and encompasses the lower portions of the Sacramento and San Joaquin river-floodplain systems as well as those of some lesser tributaries (e.g., Mokelumne River, Calaveras River).

The Sacramento-San Joaquin Delta Ecological Management Zone is characterized by a mosaic of habitats that support the system's fish, wildlife, and plant resources. Instream and surrounding topographic features influence ecological processes and functions and are major determinants of aquatic community potential. Both the quality and quantity of available habitat affect the structure and composition of the Delta's biological communities. Currently, much of the remaining natural habitats consists of small, scattered, and degraded parcels. Other, more common wildlife habitats on agricultural lands are at risk of loss because of levee failures. Important aquatic habitats are severely limited by levees and flood control systems.

Important aquatic habitats in the Delta include shaded riverine aquatic (SRA) habitat; vegetated and non-vegetated shallow shoal areas; open-ended sloughs, both large and small; and small dead-end sloughs. The large, open river channels of the Sacramento and San Joaquin rivers in the central and western Delta are more like the tidal embayments of

Suisun Bay to the west of the Delta. Areas with SRA habitat are fragmented and subject to excessive erosion from wind- and boat-generated waves. Shallow shoal areas are small and fragmented and are subject to excessive water velocities and periodic dredging that degrade or scour them.

In many areas, agricultural lands have become surrogate habitat for wildlife, partially replacing native habitats. For example, natural wetlands have been replaced by rice fields as habitat for waterfowl and natural grasses have been replaced by agricultural grains, corn, and alfalfa which provide food for geese and cranes. Agricultural lands have important benefits for wildlife in the Delta, but are not a substitute for natural habitat.

Remaining channels and sloughs have been modified to become water conveyance "facilities" and flood control features. These modifications resulted in elevated water velocities and loss of structural diversity. The few remaining small dead-end sloughs have lost their SRA habitat, are choked with water hyacinth, and have poor water quality from agricultural and dairy runoff. Reclamation of Delta islands has cut off miles of dead-end sloughs that once drained extensive tidal wetlands and has significantly reduced the amount of land-water interface.

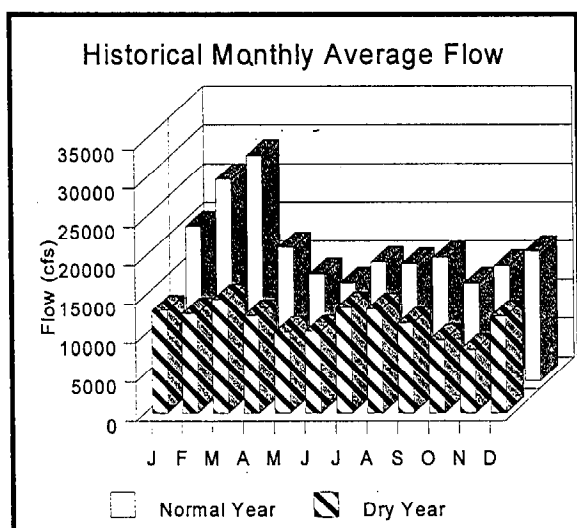
Geographic Information System (GIS) program analysis of 1906 U.S. Geological Survey maps by the California Department of Fish and Game (CDFG) provided estimates of the historical wetted perimeter in Delta sloughs and channels and tidal wetlands. [Note: Wetted perimeter is the linear measurement of shoreline. Total wetted perimeter is compared to the total acreages of related dry land within a defined area to calculate a ratio of wetted perimeter to land acreage. Higher ratios of wetted perimeter indicate a more extensive mosaic of habitats (e.g., backwaters, sloughs, floodplains, marshes, and islands).] The 1906 maps were the earliest available, and even then many Delta levees had already been constructed. These perimeter calculations were compared to similar data from GIS mapping by Pacific Meridian for CDFG using 1993 satellite imagery. That comparison indicated that there have been wetted perimeter reductions in three of the four Delta Ecological Management Units since 1906. Wetted perimeter reductions ranged from 25.2% to 44.7%.

**Change in Ratio of Wetted Perimeter
1906 to 1993
(Ratio of water to land acreage)**

Ecological Unit	1906	1993	Percentage of change
North Delta	3.4	4.5	+32.3%
East Delta	10.5	7.1	-32.4%
South Delta	11.9	8.9	-25.2%

Central Valley water supply and hydroelectric projects have had a large effect on the freshwater flow through the Delta. Spring flows that, before water projects, averaged 20,000 to 40,000 cubic feet per second (cfs) in dry years and 40,000 to 60,000 cfs in normal years have, in recent decades, averaged only 6,000 to 10,000 cfs in dry years and 15,000 to 30,000 cfs in normal years. In the driest years, spring flows were once 8,000 to 14,000 cfs, while under present conditions they average only 2,500 to 3,000 cfs.

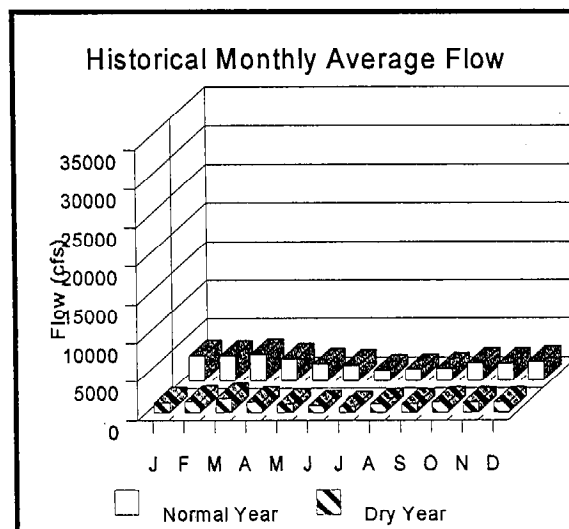
In dry and normal years, summer outflow from the Delta has remained in the 4,000 to 8,000 cfs range because water is released from reservoirs to keep salt-water from entering the Delta. Summer inflows that were only 4,000 to 8,000 cfs in dry and normal years now exceed 10,000 cfs as water is released from reservoirs to satisfy demands for water diversions.



Historical Delta Inflow from Sacramento River measured at Freeport, 1972-1992 (Dry year is the 20th percentile year; normal year is the 50th percentile or median year.)

Winter flows have fallen from the 15,000- to 60,000-cfs range to the 7,000- to 35,000-cfs range because much runoff from winter rains is now stored in foothill reservoirs. Flows in years with the highest rainfall are relatively unchanged, although short-term peaks are attenuated by flood control storage in the larger foothill reservoirs.

Much of the Delta outflow is made up of Sacramento River flow entering the Delta near Sacramento. Although inflows through the Sacramento River channel reach 60,000 to 80,000 cfs in winter and spring of wet years, inflows are generally less than 30,000 cfs. In the driest years, inflows range from 5,000 to 9,000 cfs through the entire year, while in dry years they range from 8,000 to 15,000 cfs. In wet years, floodflows that average up to 130,000 cfs per month enter the Delta from the Yolo Bypass through Cache Slough.



Historical Delta Inflow from San Joaquin River Flow measured at Vernalis, 1972-1992 (Dry year is the 20th percentile year; normal year is the 50th percentile or median year.)

Most of the remaining inflow to the Delta comes from the Mokelumne River and the San Joaquin River. The Mokelumne River contributes only 100 to 300 cfs in dry and normal years. The San Joaquin River flows make up most of the remainder with average monthly flows of 500 to 1,500 cfs in dry years, 1,500 to 3,500 cfs in normal years, and up to 20,000 to 40,000 cfs in wet years.

Water diversions from the Delta may reduce outflows by as much as 14,000 cfs. Of that total, small Delta agriculture diversions combine to divert up to approximately 3,000 cfs during peak irrigation